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Treat the Seed



Cultivate Clean



Grow Quality Potatoes

# Control Potato Diseases

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### —High Points in Potato Disease Control—

*Start with clean seed.* Wisconsin certified or inspected seed is preferred.

*Treat the seed.* Corrosive sublimate has given best results under Wisconsin conditions.

*Plant on well prepared soil.* This gives the young plants good conditions for a vigorous start.

*Cultivate the soil.* This keeps the soil loose, kills weeds, and saves moisture.

*Spray vines with arsenical poison and bordeaux for insects and diseases as needed.* Timely and thorough spraying gives good results.

*Handle potatoes with care.* Every bruise means a chance for rot germs to enter.



# Control Potato Diseases

**T**HE WISCONSIN potato grower makes his greatest profit by growing potatoes which are free from disease. Through careful treatment of seed to prevent disease and proper spraying of the crop, much can be done to insure a heavy production of potatoes of superior market merit.

Since most potato diseases are carried by the seed, and, once in the soil, are persistent, only clean seed should be grown for the seed potato trade. There is a constantly increasing demand for good seed potatoes, not only in Wisconsin, but also from other sections, especially in the southern states.

To control potato diseases the symptoms must be recognized, the cause understood, and the proper remedy applied at the right time. Some diseases are produced by unfavorable weather or soil conditions, such as drouth, heat, frost, or lightning. These are called *nonparasitic* diseases. Many other diseases, such as scab or blight, are the result of bacterial or fungus parasites or germs. These diseases are called *parasitic*.

## NONPARASITIC DISEASES

### ARSENICAL POISONING

**Symptoms.** The leaves die, usually in spots, within a few days after paris green or other arsenical poison is applied.

**Remedy.** Use poison more judiciously. If paris green is used with water, add about one pound of lime for each pound of poison; if the poison is applied dry mix with air-slaked lime; if it is used with bordeaux mixture there is no danger of injury.

### SUN SCALD

**Symptoms.** Wilting and burning of the tender young leaves occurs in June and early July during very bright, hot weather and especially after a period of warm, cloudy weather. The youngest upper shoots suffer first and worst.

**Remedy.** There is no remedy, and since the plants usually recover quickly, little permanent injury results.

### TIPBURN, HOPPERBURN

**Symptoms.** During protracted dry, hot weather in midsummer, the leaves weaken and die, beginning at their tips and mar-

gins. The older leaves and those on the lower part of the plant suffer first and worst. This is the most common trouble in Wisconsin potato fields during midsummer, especially on the earlier potatoes. Anything that weakens the plants or injures the foliage increases this trouble.



FIGURE 1.—TIP BURN OF POTATO

The leaves die, turn brown, and curl up, beginning at the tips and margins. This is the commonest trouble in Wisconsin potato fields during dry, hot midsummer. It is often mistaken for early blight. When caused by leafhopper it is called hopperburn.



Leaf hopper and flea beetle are the insects that, under Wisconsin conditions, are most frequently associated with tipburn. The injury from leaf hoppers has been so serious that it has been considered by entomologists as the chief, if not the sole, cause of much of this trouble. It is therefore well called "hopperburn" in such cases and is discussed in detail on page 20.

**Remedies.** Soil rich in humus, good surface cultivation to keep down weeds and check evaporation, thorough spraying with bordeaux mixture with the addition of insecticides (see page 20) to keep the foliage healthy, and very early or late planting of early varieties help to reduce tipburn.

#### LIGHTNING INJURY

**Symptoms.** Potato plants in a more or less circular spot in an otherwise healthy field suddenly collapse and die. The spots observed have varied from a few feet to several rods in diameter, and in most cases the injury has occurred in the first half of July. In typical cases the main stems are at once blackened and killed for some distance above and below ground, but the fibrous roots, young tubers and upper leaves may not show injury until this results from the dying of the stem. The spots do not increase much in size, and of course nothing can be done to lessen the injury after it has occurred.

#### LEAFROLL

**Symptoms.** This has proved to be a serious trouble in Colorado and some other western potato sections. In Wisconsin it occurs sparingly in some fields. It is characterized by a dwarfing and upward rolling of the leaves, beginning with the lower ones, accompanied by a change of color, in some cases to an unhealthy pale green, in others to reddish or purplish tints. The rolled leaves are thicker to the touch than normal ones. The development of the plant is checked, the tuber yield from rolled plants is small, and if such tubers are used for seed, they reproduce the disease.

Reproduction from diseased seed is the most serious phase of the matter, since Colorado growers and other users of Wisconsin seed stock wish seed free from this trouble. There is no parasite connected with leafroll, but it may be carried from plant to plant by plant-lice. It is termed for practical purposes a degenerate



condition. It is important, therefore, to eliminate diseased or degenerate tubers from the seed stock. In order to do this, the growers should carefully go over all fields being grown for seed stock and rogue them; that is, pull out all plants showing leafroll. This can best be done at about the blossoming stage, although it



FIGURE 2.—POTATO MOSAIC

The leaves are crinkled and mottled light and dark green. The mosaic plants are often much smaller than healthy plants.

is better to go over the field a second time a week or two later. If bad cases should develop get a new strain of seed or maintain an isolated seed-plot and spray against plant-lice.



## MOSAIC

**Symptoms.** This is another of the serious degeneration diseases threatening the potato crop. Superior, high producing strains of Triumph relatively free from mosaic are being located in the state through the seed tests conducted by the Horticulture Department and United States Department of Agriculture co-operating. Growers usually abandon their inferior strains as soon as their attention is called to the condition of their fields and replace them with seed of known merit.

The juice of diseased plants carries some infectious material the exact nature of which is not known. The characteristic feature is that the leaves are more or less crinkled, and mottled with irregularly distributed yellowish spots. The green areas may be raised and darker than normal. Plants are small and the yield is reduced from 10 to 80 per cent. Symptoms may be detected when the plants are 4 to 7 weeks old. The disease is most serious on the Bliss Triumph and Green Mountain varieties, and less serious on the Rural group. Plant-lice are important agents in spreading mosaic from plant to plant.

**Remedy.** There is no specific remedy for this disease. Since it is carried with the seed the way to avoid it is to use only seed from healthy plants. The crop should not be used for seed purposes if it is badly affected with mosaic because it is practically impossible to rogue out all the diseased plants. If only a moderate amount of infection occurs then the field, or such portion of it as is to be used for seed, should be frequently inspected and rogued by pulling out all diseased plants as soon as they appear. Spraying to control plant-lice is also important.

## INTERNAL SPOTTING OR BROWNING OF POTATO TUBERS

The flesh of potato tubers often shows rusty brown or blackish spots or streaks, even when the tubers appear sound on the surface. There are various types of this trouble, none of which, however, represents a serious disease in Wisconsin. The more important types which have been found here are briefly discussed below.

*Hollow Heart*

This is the familiar condition where overgrown tubers develop a cavity in the center. This is not properly a diseased condition but it is, of course, objectionable. Closer planting tends to reduce



it. The flesh immediately bordering on such a hollow heart will gradually die and turn brown. This should not, however, be confused with blackheart.

### *Blackheart*

If potato tubers are heated to a little above blood heat for a day or more, they will generally begin to die and turn dark at the center. This central portion will soon become purplish black and later may crack open. While this condition may arise in storage pits closely covered by fermenting manure it is most commonly met in car shipments, in warehouse storage in winter where a stove is used to keep out frost, or in the bottom of very deep bins. It may also develop when seed stock is exposed to the hot sun in the spring during preparation for planting.



FIGURE 3—BLACK HEART

Black heart is caused by heating at about blood heat for one day. The interior cells die first and turn black. Compare with freezing injury where the ring of fiber bundles is the first to be injured.

### *Freezing Injuries*

Exposure to low temperatures causes three kinds of injury to potatoes. (1) When potatoes are frozen solid they turn soft upon thawing. Field frosting where the side or end of the potato is exposed, is an injury of this kind. (2) Potatoes stored for a month or more at temperatures of 29° to 34° F. turn sweet without the production of ice crystals. Ice crystal formation and resulting in-



jury is almost sure to occur if potatoes are handled while the temperature is between 29° and 31° F. (3) Internal freezing injury or "frost necrosis" occurs when tubers are exposed for a few hours to temperatures slightly below 28° F. The symptoms of this are greyish brown blotches or streaks on a slightly bluish background. Such chilling may occur at any time during handling or shipping, but the greatest danger is when the tubers are stored in field pits or during midwinter storage. In recently chilled potatoes there may be no indication of trouble on the surface.

### *Internal Brown Spot*

Rusty brown spots from  $\frac{1}{8}$  to  $\frac{1}{2}$ -inch in diameter are scattered irregularly through the flesh. The disease is neither common nor serious in this state. The cause is not known with certainty, but

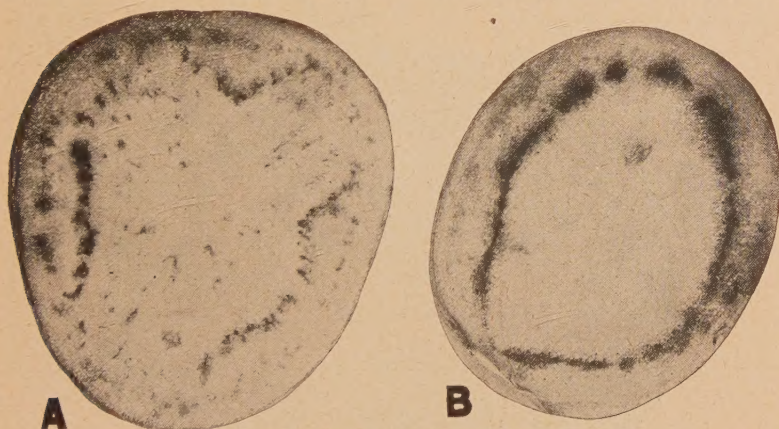


FIGURE 4—INTERNAL FREEZING INJURY

These tubers were exposed to 17 degrees F. for two hours. They did not freeze at the surface but were internally discolored. In A the vessels alone are injured showing as a network of dark lines in the flesh, net necrosis. Often, as in B, internal freezing injury shows as a dark ring which is not always complete but may be broken.

the disease is usually attributed to lack of potash or other food elements. Certainly it is not parasitic or contagious and it is not carried from year to year in the seed; therefore, no remedial considerations are called for. This may be confused with freezing injury.

### *Stem-end Browning*

Frequently upon being cut, especially if cut late in winter, potato tubers show a slight blackening of the veins penetrating the flesh



from the stem end, and occasionally this will follow the veins through the flesh as brown streaks. In many cases this simply indicates a weak tuber which is losing vitality and dying first in these regions. In some cases, however, a similar symptom is produced by the fungus wilt disease, which is caused by a parasite carried in the seed. This disease is described on page 16. Potatoes showing such symptoms should, therefore, not be used for seed.

### PARASITIC DISEASES

#### COMMON POTATO SCAB

**Cause.** Potato scab is caused by a parasitic growth on the surface of the tubers. The spores or germs are carried over winter in the old scab spots, or scattered in the dust from scabby potatoes which may cling to the surface of smooth tubers. The scab



FIGURE 5—COMMON POTATO SCAB

There are other forms of potato scab and scurf, but this is the commonest in Wisconsin. In some of the blackest spots of this specimen insects have deepened the injury. Seed disinfection and clean soil are the remedies for this disease.

parasite persists in the soil many years after a crop of scabby potatoes. It will also pass through the digestive tract of stock fed on scabby potatoes. The scab germ thrives best in an alkaline soil and is checked by acidity. Hence lime or ashes increase it, and plowing under green crops renders the soil less liable to it.

Minute insects, scab mites, and beetles often invade the scab spots and enlarge and deepen the injury. White grub and wire



worm injuries may also be coupled with those of scab, but they have no regular association and are easily distinguishable.

**Remedies.** Select smooth seed potatoes; disinfect with corrosive sublimate or formaldehyde and plant on clean soil. The use of sulphur or inoculated sulphur on the soil before planting is advocated in some states but has not as yet been proved useful under Wisconsin conditions. Clover sod is best but any green crop turned under is helpful. Cook scabby potatoes before feeding to



FIGURE 6—POTATO WART

This is the bad European disease recently introduced into Pennsylvania. Since it is one of the ugliest and worst of potato diseases, and is seed borne, every precaution should be taken to keep it out of Wisconsin.

stock and do not use fresh manure on potato land nor apply lime or ashes. Rotate potatoes with other crops, and if scab develops do not grow potatoes again on that soil for five years or more.

#### POWDERY SCAB

This is a serious disease, common in Europe and recently introduced from there into portions of Canada and Maine. It is carried on the seed, hence caution should be exercised in introducing seed potatoes from unknown sources, especially from the east. Moreover, growers and dealers, especially those handling seed



stock, should be constantly on the watch for its possible development and in doubtful cases samples should be submitted to the Agricultural Experiment Station for examination. The scab spots of common scab begin on the surface, whereas those of powdery scab begin beneath the skin, like blisters, and later break open, showing the interior filled with a dark powdery mass.

#### WART

**Symptoms.** The dangerous potato wart disease has made its appearance in three eastern states and may even be lurking elsewhere. It has never been found in Wisconsin. It is so serious, however, that a short description is given. The first symptoms are



FIGURE 7—BLACK SCURF ON TUBERS

This disease is carried from year to year in this "dirt that won't wash off". Corrosive sublimate seed treatment is the best remedy.

small spongy overgrowths on the surface, especially at the eyes. These increase in size and may become as large as the potato itself. At first the warts are white to light brown in color, then they turn darker, and finally they become black. The diseased tubers often rot in the field and are extremely likely to rot in storage. The warts that are knocked off in the field serve to infect the soil for a subsequent potato crop. The fungus lives indefinitely in the soil.

**Remedies.** There are no known remedies for wart except the use of resistant varieties. Eternal vigilance and strict quarantine are necessary to keep Wisconsin free from this disease as well as the powdery scab. The chief danger lies in the possibility of introducing these two diseases on infected seed stock from infected regions in the eastern states or from Europe. The practice of sending east for seed stock is to be discouraged.



## BLACK SCURF

**Symptoms.** Black scurf often occurs on Wisconsin tubers. It appears as black specks or flakes on the skin like "dirt that won't wash off." It really is not dirt but a fungus growth on

the skin of the potato. The greatest damage to the potato crop from the black scurf fungus is not to the tuber but to the young growing stems. The fungus frequently cuts off the stems before they break through the ground or may cause such serious brown cankers that the vitality of the plant is greatly reduced. The tuber-forming underground stems may be cut off, thus forcing an abnormal tuber development near the base of the stem or even in the axils of the leaves.



FIGURE 8—BROWN STEM CAN-KERS

The black scurf fungus, *Rhizoctonia*, attacks the stems and underground parts, causing these cankers. It frequently kills all the young shoots, causing missing hills. June is the month of most serious injury.

**Remedy.** Complete elimination of black scurf is very difficult because the fungus may live in the soil as well as be introduced with the seed tubers. Seed disinfection with corrosive sublimate and crop rotation are the best methods of control and under Wisconsin conditions are commercially satisfactory. The special benefit derived from treatment is the protection

which it affords to the young shoots as they start. The treatment kills the disease producing fungus on the tubers and allows the young plants to grow without injury. Where the fungus comes from the soil it is usually later in the season so that the young growth is not injured.

## BLACKLEG

**Appearance.** Blackleg is a bacterial disease carried on the seed tubers. It causes the seed to rot early, sometimes before the sprouts break through the ground, thus giving an irregular stand and weak plants. The rot then spreads up the base of the stem,



FIGURE 9—BLACKLEG

The old seed tuber rots, and from this the rot passes to the stem of the young plant which rots to surface of ground or above. If new tubers are set they may show soft rot in field after digging. As yet, this disease is not common in Wisconsin. Keep it out by removing diseased plants from the field.

which turns black and rots as far as the surface of the soil or above. As a result of this, the plant stops growing and the leaves become pale and bend upward, giving the plant a sickly,



narrow, and spindling appearance. Diseased plants generally die soon without setting any tubers.

The disease is worst in heavy moist soils, and in some cases, where it is bad, it may spread from the stem to the tubers, causing a rapid soft rot. Although this disease is not yet serious anywhere in Wisconsin, it occurs widely, and steps should be taken to control it before it becomes common, especially where potatoes are being grown for seed purposes.

**Remedy.** This disease is carried on the seed and is controlled by selecting sound seed potatoes and disinfecting them as for scab or black scurf. In addition, it is well to pull up all diseased plants as soon as they are detected so that they will not form tubers which might contaminate the crop.

#### WILT AND DRY ROT

**Occurrence.** Farther south and east potatoes are quite subject to two types of wilt disease and apparently one or both of these may have a slight foothold in Wisconsin. They are, however, not common and not of economic importance except for those growing seed potatoes. The aim should be to recognize them and eradicate them wherever they are found. The symptoms are so similar that for practical purposes they may be considered together. They are characterized by a wilting and falling over of the vines of infected hills in midsummer, four to six weeks before the crop should mature. There is no blackening of the stems as in blackleg, although the stem sap vessels may have a brown color. When tubers are found on these plants they are likely to show a blackened stem end running for half an inch or more into the flesh, and in storage this may develop into dry rot proceeding from the stem end.

**Control.** Any suspicious looking wilting plants should be pulled or dug and destroyed whenever seen during the summer, and seed tubers showing suspicious blackening of the interior, especially at the stem end, should be rejected. In case quick wilting occurs in a field, crop rotation should be practiced, potatoes being kept off the soil for five years or longer.

#### GRASSHOPPER

Considerable damage to potato fields is often caused by migrating swarms of grasshoppers living on meadows after harvest.



FIGURE 10.—EARLY BLIGHT

Sharply defined dead black spots appear anywhere on leaf. Quite common in Wisconsin potato fields in August and September, especially with later varieties on lighter soils. It can be prevented by spraying.



## STORAGE ROTS

Storage rots frequently cause heavy losses in cellar and storehouse. In general they are of two types, dry and wet. The dry rot may be due to infection from the field diseases, wilt or blight, or it may follow bruising, especially if the tubers are dug when green, so that the skin is easily broken. Green potatoes dug with a machine suffer more injury than do ripened ones. Dry storage rot is often characterized by a white moldy growth on the surface and in the interior.

Wet bacterial rot, which has a very bad odor, frequently occurs when blighted potatoes are kept in deep piles or are put into storage without having first been dried out in small pits. This rot frequently follows injury from later blight rot, especially where the tubers are dug early and stored under warm, moist conditions.

**Remedies.** Handle potatoes carefully to avoid bruising. Keep the storehouses cool and dry. Do not cover pits with wet vines.

## EARLY BLIGHT

**Occurrence.** This fungus disease, common in Wisconsin, causes black spotting of the leaves in late summer but does not attack the stem or tuber. As these spots enlarge and merge, the entire leaf may be killed prematurely. The disease is worst on the lighter sandy soils and on early varieties, in which cases it may reduce the yield from 10 to 25 per cent.

**Remedy.** Spray with bordeaux mixture three or four times at intervals of about two weeks during the latter half of the summer. Since the fungus lives over winter on old vine refuse, it is important to rotate crops.

## LATE BLIGHT AND ROT

**Occurrence.** As indicated by the name, late blight and rot causes the tops to blight in late summer and autumn, and this is followed by rotting of the tubers either in the field or in storage. It develops only during moist weather. Under certain conditions it is the most destructive of all potato diseases. In northern New York, New England, eastern Canada, and northern Europe, it is common in wet seasons, especially on the heavier soils, and in bad years it may destroy 50 per cent or more of the crop. It was this

disease which caused the Irish famine in 1845. Fortunately, it is not generally destructive in Wisconsin. In 1902-1904 and in 1914-1915, however, it was widespread throughout the state and



FIGURE 11.—LATE BLIGHT ROT

The rot appears as dark sunken places on the skin with the flesh underneath browned to a depth of perhaps a quarter of an inch. These start mostly on the upper side of the tuber before digging, from spores washed into the soil from the blighting leaves. Control by using bordeaux mixture on the vines. Dry storage helps.

caused general blighting of the tops, followed by much rotting of the tubers. Since that time there has been no serious epidemic until 1919, when this disease was again prevalent in certain localities. The disease is apparently present every year, in a small way at least, in the cooler, moister regions of northern Wisconsin, and the extent of its development is simply dependent upon favorable weather conditions.

**Remedy.** Do not knowingly use seed tubers from fields where late blight has occurred. Spraying with

bordeaux mixture as for early blight will control this disease, especially if the spraying is thorough and aimed at covering both sides of the leaves. More frequent applications than for early blight may be necessary in case of excessively rainy weather. If the tops are killed by late blight, do not dig the tubers until a week or more after the tops die, and then place at once in cool storage to reduce the danger from rot.

### POTATO INSECTS<sup>1</sup>

It is not the purpose of this circular to list all the potato insects, much less to describe them in detail. Only the commonest will be named in order to point out how they can be controlled when spraying for the diseases described in the preceding pages.

<sup>1</sup>H. F. Wilson of the Department of Economic Entomology has read and revised the statement relative to potato insects and their control.



## THE COLORADO POTATO BEETLE

Common potato beetles are probably the most generally injurious pests of the potato. The most important treatment for the season consists of early spraying with arsenical poisons. Thorough control of the first brood hatching on the potato plants, just as they appear above the ground, is most important. At this time, a small amount of poison, properly applied, destroys the beetles and young larvae. Isolated fields, planted late, often escape serious injury.

## FLEA-BEETLE

These tiny black beetles about the size of a pinhead often appear in great numbers in midsummer and later. Their attack on leaves soon riddles them with tiny round holes about 1/16 of an inch in diameter. Seriously damaged leaves soon dry out or turn brown at the tips. Potato blight may be distributed by the flea-beetles.

**Remedy.** The bordeaux-arsenical mixture is generally an almost perfect control for flea-beetle injury. Early varieties are preferred to late varieties by this pest.

## LEAFHOPPER

These insects have caused serious damage to Wisconsin potato fields in recent seasons. They are light green in color and obtain their food by sucking the juices from the veins of the leaves. The mature hoppers puncture the veins and insert their eggs. The young insects remain on the leaves where they were hatched until they are mature, but the full-grown ones are very lively and fly or hop from plant to plant, hence their name. Injured leaves are characterized by a marked upward curling and dying of the tip beyond the point of greatest injury. It is spoken of as "hopper-burn."

**Remedy.** Bordeaux mixture thoroughly applied is the best control known for leafhopper. The three to five applications necessary should be made under high pressure with nozzles so directed that the spray will reach both sides of the leaves. This is highly important, as simple down spraying is less efficient in reaching the undersides of the leaves where the hoppers work. This is particularly true when the weather is hot and dry so that other green food is not available. Not only the potato tips, but often the stems also, are seriously injured by grasshoppers.

The bordeaux-arsenical spray is effective in preventing injury from these insects, but a better control for grasshoppers is the use of poison bran mash made by stirring one pound of paris green or white arsenic and one pound of salt into 25 pounds of dry bran. This mixture should then be moistened with 2 or 3 gallons of water into which has been added 12 teaspoonfuls of banana oil. Use water enough to make the bran crumbly but not sloppy. By scattering this poisoned mash in the path of the grasshoppers or in adjacent fields it is possible to prevent their swarming onto the potato fields.

#### POTATO APHID

Frequently the pink and green aphids of potato occur in such numbers that control measures are advisable. Particular significance is attached to their presence, since they are now known to be an important factor in the distribution of leafroll and mosaic of potato.

**Remedy.** If control is necessary, nicotine sulfate should be added to the bordeaux-arsenical mixture, at the rate of about  $\frac{1}{2}$  pint of the sulfate to 50 gallons of the spray.

#### TOBACCO HORN WORM

In addition to the insects mentioned, the tobacco horn worm occasionally appears in serious numbers. This has been the case locally during recent years. It is a green worm the size of one's finger when mature. It is easily controlled by bordeaux-arsenical sprays, especially if these are applied in early summer, when the worms are small. If the worms are numerous and large, hand picking may be worth while.

### THE CONTROL OF POTATO DISEASES

#### THE SOIL AND ITS FERTILIZATION

The potato crop is especially sensitive to soil conditions, certain types of soil predisposing it to disease. Certain diseases, as already explained, may be carried in the manure or perpetuated in the soil; hence the importance of attention to soil and fertilization.

**Soil.** A sandy or gravelly clay loam is the best soil for potatoes. In any case avoid heavy wet soils or clays that cannot be properly drained.



**Rotation.** Rotate with other crops, planting potatoes not oftener than once in three years. Potatoes, grain, and clover make a good rotation.

**Fertilization.** Do not use fresh horse manure on potato land, or manure from other animals fed on diseased, uncooked potatoes. Do not use lime or ashes on potato land. Turning under a green crop, such as rye or clover sod, is the ideal preparation for potatoes.

#### SEED SELECTION

**Source of seed.** Avoid using seed potatoes from fields or crops that suffered badly from diseases known to be carried with the seed; that is, scab, blackleg, late blight, wilt, and the various types of rot.

**Imported seed.** *Two very serious European potato diseases threaten to invade Wisconsin unless great care is exercised. (1) Powdery scab resembles common scab but is even more difficult to control. It is common in Europe and has been found in eastern Canada and northeastern United States, especially Maine. (2) Potato wart is widespread in Europe and is there held to be the worst of all potato diseases. It has been brought into Newfoundland and the United States from Europe. Since both of these diseases are carried in seed potatoes, the United States has established a quarantine regulating the importation of potatoes from Europe and Canada. Under these circumstances no one should attempt to obtain seed potatoes from Europe, and the greatest caution should be exercised in obtaining them from the eastern United States or Canada.*

**Sorting seed.** Sort carefully just before planting, and use only clean, sound, smooth tubers for seed.

**Discolored flesh.** When cutting tubers for planting, one should keep a careful lookout for any showing discolored flesh. Badly discolored potatoes should be thrown out and not used for seed. If seed is scarce or high-priced and the discoloration is slight, especially if it is closely confined to the stem end, the tuber may be used, provided such discolored part is cut off and rejected.

#### DISINFECTION OF SEED POTATOES

The germs of scab, black scurf, and blackleg should be destroyed. They may be carried on the surface of tubers taken from a diseased crop, even though these tubers themselves appear to be smooth and healthy.

All seed tubers from unknown sources or from fields not known to be free from disease, especially if from the east, should be disinfected. It is a simple, inexpensive and harmless precautionary measure. There are two standard solutions, formaldehyde and corrosive sublimate, of which corrosive sublimate has given better results under Wisconsin conditions.

**Formaldehyde.** ..Cold Solution. Soak seed potatoes two hours in a solution of 1 pint of formaldehyde (40 per cent) in 30 gallons of water. The same solution may be used repeatedly without deterioration.

**Hot Solution.** Soak seed two minutes in a solution of 1 pint to 15 gallons of water at a temperature of 118° to 122° F. Remove tubers from solution, drain liquid back into treating tank, set tubers aside in pile and cover with blanket or canvas for one hour. This method has been devised and recommended in Iowa. Formaldehyde is not as efficient as corrosive sublimate, but it is cheaper, and it is harmless to metal tanks and stock.

**Corrosive sublimate**, also called mercuric chloride, dissolved at the rate of 1 part to 1,000, by weight, in water is more effective than the formaldehyde solution but has the drawback of being *very poisonous*. The sublimate can be secured either in tablet form or in bulk. It is colorless, tasteless, and odorless, and *if carelessly exposed it is likely to be mistaken for water*. Dissolve the tablets as directed, or dissolve 1 ounce in 1 quart of hot water and make up to 30 quarts (4 ounces to 30 gallons). Soak the uncut potatoes 30 minutes to 2 hours depending on their condition and the time of year.

1. Unsprouted seed with small amount of black scurf or scab, soak 30 minutes to 2 hours; 1½ hours is recommended.

2. Unsprouted seed with large amount of black scurf or scab, select best and soak 2 hours.

3. Sprouted seed showing small amount of black scurf or scab, soak 30 minutes.

4. Sprouted seed showing large amount of black scurf or scab, discard and obtain healthy seed, preferably Wisconsin certified.

This solution decreases in strength with use. To correct this add ½ ounce of chemical for every 4 bushels treated. Keep the amount of water up to its original volume. The amount of chem-



ical to be added after each use of the solution is based on the 2-hour soaking. If the time of treatment is shortened, reduce proportionately the amount of the chemical added. For example, if 4 bushels are soaked 30 minutes add  $\frac{1}{8}$  ounce of corrosive sublimate. Throw away the solution after it becomes very dirty. It is usually good for seven or eight lots.

Another method of handling the 1-1000 corrosive sublimate treatment is to treat the first lot of seed  $1\frac{1}{2}$  hours and to increase the time of soaking the second lot of seed to  $1\frac{3}{4}$  hours, and the third lot to 2 hours, instead of increasing the strength of the solution. After the solution has been used three times it should be discarded because of decrease in strength. This method is more expensive in chemical used, is less efficient, and takes more time, but has the advantage of being less trouble and is frequently preferred by farmers who treat a small amount of seed.

Use hose, sprinkler, pail or dip in water to wet the tubers all over, then keep covered for 24 hours before treating. This wetting allows the fungus to start and makes the treatment more effective. The time of treatment may be shortened to 30 minutes to one hour when wetting has been done.

The practice of treating the seed loose in barrels or tanks is especially commended. Galvanized iron stock-watering tanks may be used if they are first carefully painted with asphaltum paint. Otherwise, use wood or cement tanks, as metals are corroded. When barrels are used, have them on a platform so that the solution can be drawn off into a pail or tub. Do not put the potatoes into sacks, since the latter absorb corrosive sublimate and thus rapidly reduce the strength of the solution.

Treat tubers while they are dormant, if possible, and at least 10 days or 2 weeks before planting. They may be treated any time from November to May, but the objection to treating in winter is the difficulty of drying.

Tubers should be dried *immediately* after treatment. If possible, treat potatoes on a clear drying day and without rinsing. But in case of cloudy or damp weather, when a concentration of the chemical in the eye pockets might cause injury, potatoes should be rinsed in clear water after treatment. Do not make big piles of wet tubers, as injury is likely to result. Potatoes should not be used for food after this treatment. After treating in late spring avoid exposure to hot sun, since this causes black-heart and otherwise injures the seed stock.

## SPRAYING POTATOES

In spraying plants, as in most other matters of plant culture, judgment based on experience is necessary for the best success. The following directions are written with the idea of giving any practical potato grower such advice as will enable him safely to begin spraying operations. Careful study of his own conditions will then soon enable him to adapt the methods and dates of spraying to his own particular needs.

**Early applications.** As soon as the eggs of the first potato bug (Colorado beetle) hatch, make an application of an arsenical poison alone or with half-strength bordeaux mixture, that is 2-2-50. *Promptness in early spraying is the thing of chief importance.* The poison may be applied either wet or dry. The standard treatment is an application of paris green either in water,

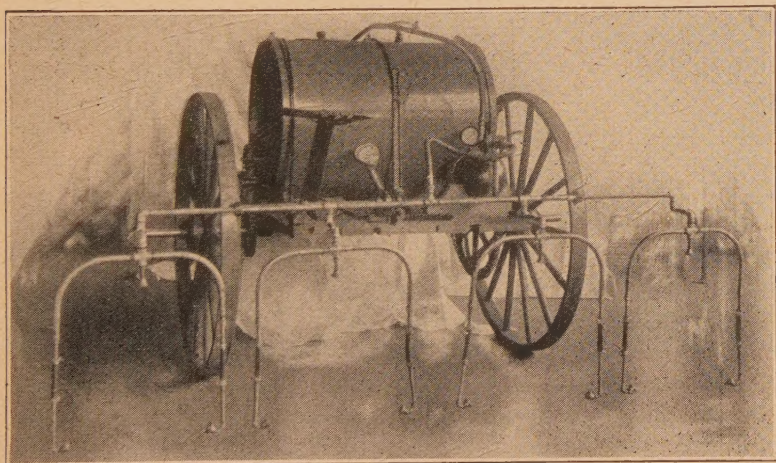


FIGURE 12.—A FOUR-ROW POTATO SPRAYER

A good sprayer should cover the vines thoroughly with spray, and keep up high pressure. Two or three nozzles to a row are better than one.

or dry and diluted with air-slaked lime or land plaster (gypsum). One or two pounds of the poison diluted with 50 gallons of water, or six pounds of dry powder is the standard application for each acre. The use of either zinc arsenite, or lead, calcium or magnesium arsenate is coming to be preferred to paris green. This has been brought about because arsenical poisoning of the potato leaves frequently follows the use of paris green, owing to the soluble arsenic contained in it. To avoid this poisoning, neutralize



the soluble arsenic by adding one pound of lime to each pound of paris green. The newer arsenicals stick to the vines better than paris green but are somewhat slower in action. They should be applied as soon as the bugs appear.

If the bugs are especially troublesome, a second application of the arsenical poison may be necessary. Otherwise, the later insects are controlled by the following sprays.

**Later applications of bordeaux mixture.** (For insects and blight.) About two weeks after the first application, that is, beginning about midsummer, spray with bordeaux mixture made as follows: (4-4-50 formula) copper sulfate 4 pounds, fresh stone lime 4 pounds (limate 6 pounds), water 50 gallons, and paris green 2 to 3 pounds or lead arsenate 3 pounds. If lice are present add nicotine sulfate.

Prepared bordeaux mixtures are now on the market in paste form and in dry form. They are somewhat more expensive than the homemade mixture but have the advantages of being more uniform and are easier to mix up. Their use is commended for small acreages or where the bordeaux making cannot be attended to by owner.

#### MAKING BORDEAUX MIXTURE

The best way to make a barrel of bordeaux is as follows: In separate tubs or barrels slake the lime and dissolve the copper sulfate in water. Strain the lime water into the barrel and add water enough to half fill the barrel. Dilute the sulfate solution with several pailfuls of water and strain this into the barrel, stirring promptly and thoroughly and adding more water as needed to fill the barrel. Add the arsenical poison and use at once. The important points to remember are that both the lime solution and the sulfate solution should be diluted with water before they are combined and that the mixture should be stirred. If this mixture is allowed to stand long, it settles to the bottom and is thereafter less effective and more likely to clog the nozzles.

If used in sufficiently large quantities, stock mixtures should be made up in advance. Use one pound of copper sulfate to each gallon of water and mix the lime and water at the same rate in separate vessels. Keep separate until ready to spray, and then use one gallon of the copper sulfate for each pound of sulfate desired and one gallon of the milk of lime for each pound of lime desired.



For example, in making the 4-4-50 mixture just recommended for insects and blight, use four gallons of each of the two stock mixtures, dilute separately; pour together and stir. If much spray is to be made, a mixing outfit should be arranged on an elevated platform, provided with a pump or other water supply and barrels to hold these stock solutions.

This application of bordeaux-arsenical mixture should be repeated about once in ten days or two weeks through midsummer according to need for control of blight and insects. In case the crop is likely to suffer severely from either early blight or late blight, it will pay to continue spraying in the same way through the late summer.



FIGURE 13.—MAKING BORDEAUX MIXTURE

If much spraying is to be done it will save time to have separate barrels of the two stock solutions. For one solution use one pound of copper sulphate to each gallon of water; for the other use one pound of lime to each gallon of water. Dilute each chemical in a separate barrel before combining in the spray tank. Add poison for the bugs, if necessary.

In case of rainy weather it may be necessary to spray every five to seven days. The main points to keep in mind are that bordeaux mixture is a preventive, not a cure, and that to prevent blight the vines must be kept covered with the spray. Spray thoroughly, using plenty of mixture under high pressure. (From 150 to 200 pounds is recommended.)

## ROGUE POTATO FIELDS

Every one growing potatoes primarily for seed purposes should go over his field at least twice during midsummer, preferably about blossoming time, and rogue the crop. If many plants have to be removed it is well to go over the ground a second time, a week or two later. This will, of course, be primarily for the purpose of pulling out all plants not true to varietal type. At the same time a sharp watch should be kept for any tops showing symptoms of the leaf-roll, mosaic, blackleg, or wilt diseases. Any such should be pulled to prevent tuber formation. If one is merely growing his own seed, it may ordinarily suffice to thus carefully rogue only a portion of the field from which the seed stock may then be taken.

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